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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:
Raphael Yair et al.

Serial No.: 09/541,354

Filed: March 31, 2000

For: SWITCHING DEVICE TO LINEARLY CONDUCT A CURRENT BETWEEN A SOURCE AND A LOAD

Group Art Unit: 2859

Examiner: Fetzner, Tiffany A.

Atty. Docket: GEMS:0075/YOD 32-NM-5321

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APPEAL BRIEF PURSUANT TO 37 C.F.R. §§ 1.191 AND 1.192

This Appeal Brief is being filed in triplicate in furtherance to the Notice of Appeal filed on November 17, 2003.

1. REAL PARTY IN INTEREST

The real party in interest is GE Medical Technology Services, Inc., the Assignee of the above-referenced application by virtue of the Assignment recorded at reel 010722, frame 0508, and recorded on March 31, 2000. GE Medical Technology Services, Inc., the Assignee of the above-referenced application, as evidenced by the documents mentioned above, will be directly affected by the Board's decision in the pending appeal.

2. RELATED APPEALS AND INTERFERENCES

Appellants are unaware of any other appeals or interferences related to this Appeal.

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3. STATUS OF CLAIMS

Claims 1-3, 5-23 and 25-28 are currently pending, and claims 1-3, 5-23 and 25-28 are currently under final rejection and, thus, are the subject of this appeal.

4. STATUS OF AMENDMENTS

All proposed amendments have been entered and considered.

5. SUMMARY OF THE INVENTION AND OF THE DISCLOSED EMBODIMENTS

In MR imaging systems, failure to maintain uninterrupted linear conduction of current between the gradient amplifier and the gradient coils may compromise the pulse sequence and result in poor imaging performance. Accordingly, the switching assembly that directs the gradient current from the amplifier to the coils should be capable of uninterrupted linear conduction. A problem with conventional systems is that when gradient currents approach zero during normal MRI operation, typical switching devices that direct the gradient current may become non-conductive. In response, the present technique takes into account the magnitude of the current flowing through the gradient coils, and provides for a switching circuit or assembly configured to substantially linearly conduct current between the gradient amplifiers and gradient coils, even if the gradient current approaches zero. Moreover, with phases of operation of the switching device dependent on the magnitude of the current applied to the coils, the switching devices (e.g., steering circuit discussed below) that conduct the gradient current at low levels (e.g., hundreds of milliamperes) may be advantageously sized as smaller components.

As illustrated in Fig. 5 of the application, the present switching assembly 90 includes a switching device 102 and a steering circuit 104 coupled in parallel between the drive 101 (e.g., gradient amplifier) and the load 103 (e.g., gradient coils). The steering circuit 104 is provided to direct the current between the drive 101 and the load 103 in the event that the switching device 102 cannot conduct current in a linear or uninterrupted manner, such as when the magnitude of the current is below a threshold value. For example, as best illustrated in Figs. 8 and 9 of the application, as the magnitude of the current approaches zero, the switching device 102 may fail to conduct current from the drive 101 to the load 103. To ensure uninterrupted linear flow of

current, the steering circuit 104 conducts current at these very low levels (e.g., hundreds of milliamperes) when the switching device 102 is in a non-conducting state. Thus, it is clear that the conductive states of the switching device and steering circuit are *dependent on the magnitude of the current through the gradient coils*. Again, an advantage in basing conductive states within the switching assembly 90 on the magnitude of the current applied to the gradient coils is that the steering circuit 104 will typically conduct only low levels of current. Thus, the steering circuit 104 may comprise smaller non-power components, reducing the size of the steering circuit 104 and improving the packaging of the switching assembly 90.

6. **ISSUES**

Issue No. 1:

Whether claim 1 is unpatentable under 35 U.S.C. § 102 (b) as being anticipated by Macovski et al. (U.S. Pat. No. 5,835,995).

Issue No. 2:

Whether claims 1, 2, 3, 5, 6, 10-13, 18, 23, 25 and 28 are unpatentable under 35 U.S.C. § 102 (e) as being anticipated by Van Groningen (U.S. Pat. No. 6,140,873).

Issue No. 3:

Whether claims 7-9, 14, 15 and 19 are unpatentable under 35 U.S.C. § 103 (a) as being obvious over Van Groningen (U.S. Pat. No. 6,140,873) in view of Mansfield et al. (U.S. Pat. No. 4,820,986) or alternatively Macovski et al. (U.S. Pat. No. 5,835,995).

Issue No. 4:

Whether claims 16, 20, and 26 are unpatentable under 35 U.S.C. § 103 (a) as being obvious over Van Groningen (U.S. Pat. No. 6,140,873) in view of Vavrek et al. (U.S. Pat. No. 5,311,135).

Issue No. 5:

Whether claims 17, 22, and 27 are unpatentable under 35 U.S.C. § 103 (a) as being obvious over Van Groningen (U.S. Pat. No. 6,140,873) in view of Vavrek et al. (U.S. Pat. No. 5,311,135).

Issue No. 6:

Whether claim 21 is unpatentable under 35 U.S.C. § 103 (a) as being obvious over Van Groningen (U.S. Pat. No. 6,140,873) in view of Vavrek et al. (U.S. Pat. No. 5,311,135) and Mansfield et al. (U.S. Pat. No. 4,820,986) or alternatively Vavrek et al. (U.S. Pat. No. 5,311,135) and Macovski et al. (U.S. Pat. No. 5,835,995).

7. GROUPING OF CLAIMS

The claims may collectively stand or fall for purposes of this Appeal only.

8. ARGUMENT

As discussed in detail below, the Examiner has improperly rejected pending claims 1-3, 5-23 and 25-28. The Examiner has misapplied long-standing and binding legal precedents and principles in rejecting the claims under 35 U.S.C. § 102 and 35 U.S.C. § 103. Appellant believes that this application should have been allowed in view of the Responses to the rejections filed in the present case. Accordingly, Appellant respectfully requests full and favorable consideration by the Board, as Appellant strongly believes that claims 1-3, 5-23 and 25-28 are currently in condition for allowance.

Issue No. 1:

In the most recent Official Action mailed on August 19, 2003, the Examiner rejected claim 1 under 35 U.S.C. §102(b) as being anticipated by Macovski et al. (U.S. Pat. No. 5,835,995). Appellants respectfully traverse this rejection. A *prima facie* case of anticipation under 35 U.S.C. § 102 requires a showing that each limitation of a claim is

found in a single reference, practice or device. *In re Donohue*, 226 U.S.P.Q. 619, 621 (Fed. Cir. 1985).

The Examiner argues incorrectly that Macovski et al. reference discloses a switching device having "a first phase of operation dependent on the magnitude of the current applied to the load," as recited by rejected claim 1. To the contrary, the positions of the switches disclosed in the Macovski et al. reference are selected *by a control input without consideration of the current applied to the load* (coil 11). In fact, timing of the switches depend on factors external to the circuitry, such as the patient's cardiac cycle. As discussed below, the Examiner has failed to show that Macovski et al. reference recites all of the elements of claim 1, and thus has not established a *prima facie* case of anticipation.

The Macovski et al. reference is directed to resolving issues with cardiac imaging timing that are difficult because of cardiac and respiratory motion. Macovski et al., col. 1, lines 29-37. An energy recovery system is used to conserve the energy from the high magnetic fields generated to correct the motion problems. Macovski et al., col. 3, lines 53-67. Various switches and capacitors may be configured in the energy recovery system. Macovski et al., col. 4, lines 1-49. In particular, switches 21, 26, 32, and 34 are opened and closed to control the flow of current and to manage the ramp up and ramp down periods. Macovski et al., col. 4, lines 1-49. Finally, it is clear that the conductive states of the switches are dependent on an external control input and are not determined by the current applied to a load.

In the rejection, the Examiner identifies the discussion of Figs. 3-5 of the Macovski et al. reference to disclose the recited features of independent claim 1. The Examiner cited switches 32 and 34 as correlating to the steering circuit of the recited claims. However, as previously asserted, the Macovski et al. reference fails to disclose a switching device having a "first phase of operation dependent on the magnitude of the current applied to the load," as recited by rejected claim 1. Instead, the Macovski et al. reference discloses that the switch positions are altered when it is desired to charge the coil 11, or to maintain the field, or to ramp down the coil 11. For example, a switch 21 is moved to position 23 to charge the coil 11. Macovski et al., col.

4, lines 1-5. Subsequently, the switch 21 is opened and a switch 26 is closed once a desired field is reached. Macovski et al., col. 4, lines 5-10. Finally, for the downramp 42, the switch 26 is opened and the switch 21 is moved to position 24. Macovski et al., col. 4, lines 10-13. Optional switches 32 and 34 may be used to decrease or increase the downramp or up ramp time for the system. Macovski et al., col. 4, lines 31-49. Clearly, no phase of operation is *dependent* on the *magnitude of the current*, but is controlled by the switches 21, 26, 32, and 34. As such, the Macovski et al. reference fails to disclose a first phase that depends upon the magnitude of the current applied to the load, as claimed.

The Examiner disagreed with Appellants' arguments, asserting:

> Applicant argues [that] the Marcovski et al., reference which controls the flow of current with switches (i.e., this limitation is required by applicant's claim 1, because applicant claims "a switching circuit which linearly conducts current between a source and a load") is directed to a different issue. However, applicant's claim 1 is directed to just a switching circuit to conduct a current. Therefore any circuit which directs current linearly between a source and a load meets applicant's claim 1. The fact that the Marcovski et al., reference uses the Marcovski et al., switching circuit in MR cardiac imaging, fails to eliminate the Marcovski et al. reference as prior art, because the limitations claimed by the applicant are still met by the reference. Applicant's argument is not persuasive.

Paper No. 10, page 2, paragraph 4A.

Appellants respectfully disagree with the Examiner's assertion that any circuit which directs current linearly between a source and a load anticipates claim 1. To the contrary, anticipation under 35 U.S.C. § 102 can be found only if a single reference shows exactly what is claimed. *Titanium Metals Corp. v. Banner*, 778 F.2d 775, 227 U.S.P.Q. 773 (Fed. Cir. 1985). The cited reference fails this standard with respect to claim 1 for at least the reason that the reference does not disclose a phase of operation "dependent on the magnitude of the current applied to the load." In short, the Macovski et al. et al. reference does not disclose all of the limitations of claim 1.

Appellants agree with the Examiner that the primary use of the Macovski et al. switching circuit in cardiac imaging does not necessarily eliminate the reference as prior art. However, recognition of this focus of the reference is useful in understanding the deficiencies of the reference. For example, as discussed below, the reference discloses a preference for timing the operation of the switches to the patient's cardiac cycle, a factor clearly external to the circuitry and not "dependent on the magnitude of the current applied to the load," as recited by claim 1. *See* Makovski et al., col. 4, lines 55-61.

The Examiner further stated:

> Applicant argues [that] the Marcovski et al. reference fails to disclose a switching device having a "first phase of operation dependent on the magnitude of the current applied to the load." However, Marcovski et al., shows and teaches a switching device with a first phase (i.e., at least one switch in a first position until a specified set of conditions are met) and a second phase (i.e., at least one switch in a second position when a second set of conditions are met) that affects the inductive load component 11.

Paper No. 10, pages 2-3, paragraph 4B.

The Examiner asserts that Marcovski et al. discloses first and second phases of operation of at least one switch dependent on a "specified set of conditions." Operation of the Marcovski et al. switches, however, are not dependent on magnet current, but instead is controlled by a computer program to give the desired ramp slopes and times. In particular, the switching devices that conduct current to the load (coils) in the Macovski et al. device are "actuated by a pre-set computer program." Such actuation is dependent on desired ramp up and ramp down intervals. Macovski et al., col. 4, lines 1-46, 53-54. Thus, again, the positions of the switches are manipulated by an external control input. The reference does not disclose a switching device having a conductive state dependent on the magnitude of a current.

Conversely, in the present application, as illustrated in Figs. 4-6, after exemplary switching assemblies 90 are enabled by a control circuit (i.e., 40 or 105), the *conductive states of*

switching devices (i.e., 102, 104, 114, 116, 106, 108) within the assemblies 90 *are clearly decided by the magnitude of the current applied to the load* (i.e., 26, 41-45, 103). Again, this is in sharp contrast to the cited reference, in which the conductive states of the switches are independent of the current applied to the load. For example, in the Macovski et al. reference, the conductive states of switches 21 and 26 are adjusted to initiate a downramp 42, with no consideration of the magnitude of the current applied to the load. Indeed, prior to the downramp 42, the magnitude of the current is at a constant peak value, hardly a changing variable that might initiate a change in the conductive state of a switch. *See* Macovski et al., col. 5-13. And just as striking, the cited reference suggests that the timing of the switches will preferentially depend completely on factors external to the disclosed circuitry (and not to the magnitude of the current through the coils):

> With cardiac studies, which is one of the primary uses of this invention, the switches would be timed to the cardiac cycle using a signal derived from the beating heart such as the electrocardiogram. When making a static image of the heart, as with a coronary angiogram, the system is timed to an appropriate part of the heart cycle . . . .

Macovski et al., col. 4, lines 55-61.

The Examiner's confusion is highlighted by the Examiner's incorrect characterization of the operation of the capacitor 25 in the Macovski et al. reference:

> Marcovski et al., teaches that the switches are activated or deactivated dependent upon the rate of change of current (i.e. di/dt) charging/discharging a capacitor, [See col. 4 line 1 through col. 6 line 11] and because the rate of change of current (i.e. di/dt) charging/discharging a capacitor is related to the current magnitude in the circuit containing the capacitor, depending on the situational position of the switches of Figure 4, and different for a second position of the switches of Figure 4, thus applicant's argument is not persuasive.

Paper No. 10, page 3, paragraph 4B.

Appellants respectfully disagree. Even if the current ramp di/dt, which is a function of voltage 22 (E) and inductance of the coils 11 (L), is related to the current charging/discharging

the capacitor 25 or to the magnitude of the current in the coils 11, none of these variables affect operation of the Makovski et al. switches. *See* Macovski et al., col. 4, lines 6-7. It is clear that the current ramp di/dt (or any other current variables) does not decide the position or conductive states of switching devices in the disclosed circuitry. Instead, the positions of the switches are determined by external factors, such as initially, when the user (or pre-set computer program) decides to *manipulate* the switches to charge the capacitor 25 and to initiate the cardiac imaging sequence. The capacitor is initially charged through diode 26, and then discharged to the coils for a di/dt ramp up. Macovski et al., col. 4, lines 1-6 (noting that after the capacitor is charged, "the pulse is initiated by *turning* switch 21," and after achieving the desired magnetic field, the "switch 21 is *put* in a [different] position and switch 26 is *turned on*") (emphases added). To complete the energy recovery cycle, a reverse voltage is applied for the downramp, the capacitor 25 receiving a return charge from the coils 11. Macovski et al., col. 4, lines 10-15 (explaining that to discharge the coils 11, the "switch 26 is *opened* and switch 21 is *moved*") (emphases added).

It should be apparent that the Examiner's focus on the capacitor 25 in rejecting the present claims is misplaced. The capacitor 25 is provided for energy recovery and has nothing to do with deciding the position of the switches. Quite the opposite, the operation of the capacitor is instead dependent on the position of the switches, and not vice versa.

In summary, the Makovski et al. reference does not disclose a switching device having phases of operation "dependent on the magnitude of the current applied to the load," as recited by rejected claim 1. Because the Examiner has failed to show that the prior art recites each element of the claimed invention, the Makovski et al. reference can not anticipate the present claims. Consequently, independent claim 1 and its respective dependent claims 2-3 and 5-9 are believed to be patentable over the Makovski et al. reference. Accordingly, Appellant believes claims 1-3 and 5-9 are currently in condition for allowance, and respectfully requests favorable consideration by the Board.

Issue No. 2:

The Examiner rejected claims 1, 2, 3, 5, 6, 10-13, 18, 23, 25 and 28 under 35 U.S.C. §102 (e) as being anticipated by Van Groningen (U.S. Pat. No. 6,140,873). Appellants respectfully traverse this rejection. To maintain a proper rejection under 35 U.S.C. § 102, a single reference must teach each and every element or step of the rejected claim. *Atlas Powder v. E.I. du Pont,* 750 F.2d 1569 (Fed. Cir. 1984). The Examiner rejected each of independent claims 1, 10, 18 and 23, which recite similar subject matter and were rejected based on the same elements of the Van Groningen reference. Therefore, the independent claims 1, 10, 18 and 23 are discussed together.

Initially, Appellants note that because the magnitude of the current through the load 70 in the Van Groningen reference is assumed constant, the Examiner relied on an amplifier component having variable current flow in an effort to anticipate the claims. In particular, the Examiner equated, incorrectly, the self-inductor 58 (having a "boost" current) of the Van Groningen reference with the "load" and "gradient coils assembly" of the present application. It is clear, however, that the "load" of the present application is separate from the switching device, steering circuit, and overall switching assembly. In contrast, the self-inductor 58 of the Van Groningen reference is a component within the amplifier/switching circuitry and therefore cannot be equated with the "load" or "gradient coils" of the present claims.

In the present application, the switching assembly is disposed *between* the source and the load (or between the amplifier and gradient coil assembly). For example, claim 1 recites, "a switching device coupled *between* the source and the load." Thus, it is not possible for the load to be a part of the switching device or assembly. The load receives (or returns) current from the switching assembly, and is separate from the switching circuitry. After all, a purpose of the switching assembly is to conduct current *to the load*. Dissimilarly, the self-inductor 58 of the cited reference is part of the switching circuitry and clearly cannot conduct current to itself. Indeed, the self-inductor 58 is a component utilized in the conduction of current *to the load 70.*

In sum, the Examiner's labeling of the self-inductor 58 of the cited reference as the load or gradient coil assembly of the present application is plainly misplaced. The Examiner has not

challenged that the current in load 70 or through the gradient coils 3 is constant, but instead has interpreted erroneously the self-inductor 58 within the Van Groningen switching circuitry as the load or gradient coils of the present application. Accordingly, because operation of the switches in the Van Groningen reference does not *depend* on the *magnitude of the current applied to the load or gradient coil assembly*, as recited in the claims, the Van Groningen switches fail to anticipate the recited feature.

In general, as recited in the pending claims and as particularly described in the specification of the instant application, the switching device and the steering circuit are different, independent circuits that are connected in parallel to permit current to be supplied to a gradient coil assembly even when the switching device ceases to conduct current. It is clear that the steering circuit and the switching device are configured to alternately conduct current depending on the current level. As discussed above, the current steering circuit 104 is coupled in parallel with the switching device 102 to provide an alternate path between the drive 101 (e.g., amplifier 96) and the load 103 (e.g., gradient coil 42), which depends on the magnitude of the current. As shown in the waveforms 152 and 160, the steering circuit and the switching device operate to ensure that current is conducted to the gradient coil assembly during substantially the entire duration of the first current pulse.

Conversely, the Van Groningen reference is directed to resolving switching losses in amplifiers because of the switching over from one state to another. Van Groningen, col. 2, lines 30-43. To resolve this problem, the Van Groningen reference utilizes "soft switching," which is intended to minimize the current loss through the switches. Van Groningen, col. 2, lines 44-53. The reference teaches using a capacitor in parallel with a controllable switch to ensure that the voltage across the switches is nearly zero. Van Groningen, col. 3, line 61 to col. 4, line 21. The transistors 36 and 38 are *controllable* switches that are activated and deactivated by a control input. Van Groningen, col. 3, lines 30-42; col. 8 lines 7-26. The Van Groningen reference discloses three situations to illustrate the "soft switching" in the circuit, which involve switching over between a diode 42 and a transistor 36. Van Groningen, col. 7, line 46 to col. 9, line 33. In each of the situations, the voltage level at the switch is adjusted before being activated or

deactivated. Van Groningen, col. 7, line 46 to col. 9, line 33. During the situations, a boost current and a clamping phase may be used, while *the current through the load 70 is assumed to be constant*. Van Groningen, col. 7, line 46 to col. 8, line 36.

In the rejection, the Examiner asserted that the Van Groningen reference discloses all of the recited features. Further, the Examiner asserted that the transistors 36 and 38 are equivalent to the switching device and the components 60-1, 60-2, 60-3, 64-1, 64-2, and 64-3 are equivalent to the current steering circuit. However, the Van Groningen reference does not disclose or suggest all of the recited features of the claims. For example, the Van Groningen reference does not provide *a first phase of operation* or *a first portion* that is *dependent* on the *magnitude of the current applied to the load or gradient coil assembly.*

In the rejection, the Examiner asserted that the transistors 36 and 38 are equivalent to the switching device recited in the claims. In the Van Groningen reference, the only description of the current through the load 70 indicates that the load current is assumed to be constant. Van Groningen, col. 7, lines 57-59; col. 9, lines 66-67. The magnitude of the current is not even a factor for the operation of the switches 36 and 38. This is because the *controllable* switches 36 and 38 operate from a control input, not the magnitude of the current applied to the load. Van Groningen, col. 3, lines 30-42. Specifically, to comply with the soft switching, as taught by the reference, the *boost current*, and not the load current, is utilized to adjust the voltage differential across the switch 36 or 38 to nearly zero to allow the switch to switch over in a lossless manner Van Groningen, col. 2, lines 44-51; col. 8, lines 7-23. Because operation of the switches 36 and 38 do not *depend* on the *magnitude of the current applied to the load or gradient coil assembly*, as recited in the claims, the switches 36 and 38 fail to anticipate the recited feature.

The Examiner disagreed, stating:

> Applicant argues [that] the Van Groningen reference which minimizes current loss through switches is directed to a different issue than applicant's invention. However, applicant's claim 1 is directed to just a switching circuit to conduct a current. Therefore the fact that the Van Groningen reference uses the Van Groningen switching circuit to resolve switching losses in MR amplifiers,

> fails to eliminate the Van Groningen referenced as prior art, because the limitations claimed by applicant are still met by the reference.

Paper No. 10, page 3, paragraph 4C.

Appellants clarify that claim 1 is directed to "a switching circuit to linearly conduct current between a source and a load," as recited in the preamble. Furthermore, Appellants agree with the Examiner that the fact that the Van Groningen reference is directed to minimizing switching losses in MR amplifiers does not necessarily eliminate the Van Groningen reference as prior art. It is useful, however, to recognize this very different focus of the cited reference in understanding the deficiencies of the reference. For example, because the purpose of Van Groningen is to minimize losses in the switching between a diode 42 and a transistor 36 *within the amplifier*, the reference only minimally addresses the current through load 70 or gradient coils 3. The reference discusses the magnitude of the current through the amplifier components, such as the current through the self-inductor 58, but does not directly address the magnitude of the current through the load (except for indicating that the current through the load is constant). Thus, the Examiner has erroneously disregarded the teaching of Van Groningen regarding the current through the load 70 or gradient coil 3, but instead relies on the disclosed changing current through amplifier components in an effort to anticipate the claims. For example, as discussed above, the Examiner treats an amplifier component, the self-inductor 58, as a "load." A problem with this approach, however, (as clearly established by the subject matter of the present claims) is that the "load" of the present claims is not part of the "source" or "amplifier" or "switching assembly," and thus the self-inductor 58 (which is part of the amplifier/switching circuitry) of the cited reference is not equivalent to the "load" of the present application.

And just as striking, while the focus of Van Groningen is minimizing switching losses with assumed satisfactory delivery of current to the load 70, the current flowing through the amplifier components, such as through the self-inductor 58, is not necessarily uninterrupted or linear. For example, unlike the current flowing through the "load" of the claims, it is not important for the current through the self-inductor 58 to be linear. In fact, at the time of switching disclosed in the Van Groningen reference (i.e., during the resonant switching phase),

the current through the self-inductor is not linear but sinusoidal in form. Van Groningen, col. 8, lines 6-8, 14-16, 65-67.

In the most recent Office Action, the Examiner argued that the position of the Van Groningen switches in Figures 2, 3, and 4 are situational, with the magnitude of the current applied to inductor 58 of Figure 2 changing for each situation. The Examiner cited col. 5 line 66 through col.11 line 11 of the reference and again reasoned incorrectly that the inductive component 58 is also effectively a load within Van Groningen's circuitry (through which current passes), and interpreted that each of the positional switch situations is "a first phase of operation or a first portion" (i.e. a first set of switch positions) that is "dependent on the magnitude of the current applied to the load" (or "gradient coil assembly"), with the "load" being the inductive component 58 of Figure 2. The Examiner continues to equate, incorrectly, the self-inductor 58 (which is not the load 70 but is a component of the switching circuitry) of the cited reference with the "load" or "gradient coil assembly" recited in the present claims. Appellants have carefully reviewed the portions of the reference cited by the Examiner and respectfully disagree that the inductive component 58 is equivalent to the load of the present application.

What is more, the Van Groningen reference also fails to disclose a *second switching device* or *current steering circuit* having a *second portion* of *current to the load or gradient coils* being "below a non-zero threshold value." In the rejection, the Examiner asserted that components 60-1, 60-2, 60-3, 64-1, 64-2, and 64-3 of Van Groningen are equivalent to the current steering circuit. However, as discussed previously, the only disclosure in the Van Groningen reference related to the current through the load 70 is that it is assumed to be constant. Van Groningen, col. 7, lines 57-59; col. 9, lines 66-67. In fact, the reference is devoid of any disclosure that the current through the load falls "below a non-zero threshold value" or that any action is taken based upon such events. Accordingly, the reference cannot disclose or anticipate a *second portion of current* to the *load* or *gradient coil assembly* that is "below a non-zero threshold value."

The Examiner responded, erroneously, that the Van Groningen reference teaches a *second switching device* or *steering circuit* (citing the components of Figure 2) having a *second portion of current to the load* (i.e., a second configuration of switch positions) resulting in an alteration of current through the inductive load component 58. Furthermore, the Examiner misinterpreted the "half-period" disclosed in the reference as the "non-zero-threshold value" recited in the claims. Finally, the Examiner concluded that "because the reference teaches the switching which occurs in each type of situation depends upon the amount of current through the switch components, the applicant's argument [stating] that the Van Groningen reference is devoid of action which occurs when current through the load (i.e. interpreted by the examiner as inductive component 58) falls below 'a non-zero threshold value' is not persuasive." Paper No. 10, pages 3-4, paragraph 4D.

Again, Appellants note that the self-inductor 58 obviously not a gradient coil assembly, and is not a "load" described by the claims for at least the reason of the different location of the self-inductor 58 compared to the location of the load (and gradient coils) of the present application. Even the Examiner has acknowledged that the self-inductor 58 is disposed within the switching circuitry, and thus the Examiner's configuration of the self-inductor 58 as a "load" is inconsistent with the present claims. *See* Paper No. 10, page 4, paragraph 4D (noting that self-inductor 58 is also effectively a load within Van Groningen's circuitry and that the switching depends upon the amount of current through the self-inductor 58, a switching component). The "load" in the present claims is not part of the amplifier or switching assembly but receives current from the amplifier and switching assembly. Moreover, as previously indicated, the self-inductor 58 is used to minimize switching losses within the amplifier and does not require linear uninterrupted flow of current, whereas the gradient coils of the present application are used to generate gradient magnetic fields and require linear uninterrupted flow of current. Furthermore, the "half-period" discussed in the Van Groningen reference is not equivalent to the "non-zero threshold value," as recited in the claims. Appellants repeat that the only disclosure in the Van Groningen reference related to the current through the load 70 is that it is assumed to be constant. Van Groningen, col. 7, lines 57-59; col. 9, lines 66-67. Appellants also repeat that the reference is devoid of any disclosure that the current through the load falls "below a non-zero threshold

value" or that any action is taken based upon such events. Accordingly, the reference cannot disclose or anticipate a *second portion of current* to the *load* or *gradient coil assembly* that is "below a non-zero threshold value."

In view of the remarks set forth above, Appellants respectfully submit that the subject matter of independent claims 1, 10, 18 and 23, as well as the claims dependent thereon, is not anticipated by Van Groningen reference. Accordingly, Appellants believe claims 1-3, 5, 6, 10-13, 18, 23, 25 and 28 are currently in condition for allowance, and respectfully requests favorable consideration by the Board.

Issue No. 3:

Claims 7-9, 14, 15 and 19 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Van Groningen (U.S. Pat. No. 6,140,873) in view of Mansfield et al. (U.S. Pat. No. 4,820,986) or alternatively Macovski et al. (U.S. Pat. No. 5,835,995). As discussed above, all of the independent claims are believed to be allowable over the Van Groningen reference. The Examiner relied upon the Mansfield et al. reference or the Macovski et al. reference to disclose or teach a "switching device comprises a silicon controlled rectifier (SCR)." However, the Mansfield et al. reference and the Macovski et al. reference do nothing to obviate the deficiencies of the Van Groningen reference discussed above. Moreover, the Examiner has yet to provide a convincing line of reasoning for the proposed combination. Appellants believe that the teachings are not in fact amenable to a workable combination. Therefore, all of the cited dependent claims are believed to be patentable for the subject matter they separately recite as well as by virtue of their dependency on their respective allowable base claims 1, 10, and 18. Accordingly, Appellants believe claims 7-9, 14, 15 and 19 are currently in condition for allowance, and respectfully requests favorable consideration by the Board.

Issue No. 4:

The Examiner rejected claims 16, 20, and 26 under 35 U.S.C. 103(a) as being unpatentable over Van Groningen (U.S. Pat. No. 6,140,873) in view of Vavrek et al. (U.S. Pat. No. 5,311,135). As discussed above, all of the independent claims are believed to be allowable

over the Van Groningen reference. In the rejection, the Examiner appears to rely on Vavrek et al. to the disclose or teach the "gradient coil assembly." However, the Vavrek et al. reference does nothing to obviate the deficiencies of the Van Groningen reference with regard to the deficiencies discussed above. Moreover, the Examiner has yet to provide a convincing line of reasoning for the proposed combination. Appellants believe that the teachings are not in fact amenable to a workable combination. Accordingly, all of the cited dependent claims are believed to be patentable for the subject matter they separately recite as well as by virtue of their dependency on an allowable base claim. Therefore, Appellants believe claims 16, 20, and 26 are currently in condition for allowance, and respectfully requests favorable consideration by the Board.

Issue No. 5:

The Examiner rejected claims 17, 22, and 27 under 35 U.S.C. 103(a) as being unpatentable over Van Groningen (U.S. Pat. No. 6,140,873) in view of Vavrek et al. (U.S. Pat. No. 5,311,135). As discussed above, all of the independent claims are believed to be allowable over the Van Groningen reference. In the rejection, the Examiner relied on Vavrek et al. to the disclose or teach the "a first gradient coil set and a second gradient coil set" and "the switch assembly selectively couples the amplifier to either the first gradient coil set or the second gradient coil set." However, the Vavrek et al. reference does nothing to obviate the deficiencies of the Van Groningen reference with regard to the deficiencies discussed above. Moreover, the Examiner has yet to provide a convincing line of reasoning for the proposed combination. Appellants believe that the teachings are not in fact amenable to a workable combination. Accordingly, all of the cited dependent claims are believed to be patentable for the subject matter they separately recite as well as by virtue of their dependency on an allowable base claim. Therefore, Appellants believe claims 17, 22, and 27 are currently in condition for allowance, and respectfully requests favorable consideration by the Board.

Issue No. 6:

Claim 21 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Van Groningen (U.S. Pat. No. 6,140,873) in view of Vavrek et al. (U.S. Pat. No. 5,311,135) and

Mansfield et al. (U.S. Pat. No. 4,820,986) or alternatively Vavrek et al. (U.S. Pat. No. 5,311,135) and Macovski et al. (U.S. Pat. No. 5,835,995). As discussed above, the independent claim 18 is believed to be allowable over the Van Groningen reference, and dependent claim 20 is believed to be allowable over Van Groningen in view of Vavrek et al. The Examiner relied upon the Mansfield et al. or Macovski et al. reference to disclose or teach "the first switch device and the third switching device each comprises a silicon controlled rectifier." However, the Mansfield et al. reference and Macovski et al. reference do nothing to obviate the deficiencies of the Van Groningen and Vavrek et al. references discussed above. Moreover, the Examiner has yet to provide a convincing line of reasoning for the proposed combination. Appellants believe that the teachings are not in fact amenable to a workable combination. Accordingly, dependent claim 21 is believed to be patentable for the subject matter it recites as well as by virtue of its dependency on allowable base claim 18. Accordingly, Appellants believe claim 21 is currently in condition for allowance, and respectfully requests favorable consideration by the Board..

CONCLUSION

In view of the above remarks, Appellants respectfully submit that the Examiner has provided no supportable position or evidence that claims 1, 2, 3, 5, 6, 10-13, 18, 23, 25 and 28 are anticipated under 35 U.S.C. § 102. Accordingly, Appellants respectfully request that the Board find claims 1, 2, 3, 5, 6, 10-13, 18, 23, 25 and 28 patentable over the prior art of record, withdraw all outstanding rejections, and allow claims 1, 2, 3, 5, 6, 10-13, 18, 23, 25 and 28.

Furthermore, in view of the above remarks, Appellants respectfully submit that the Examiner has provided no supportable position or evidence that remaining pending claims 7-9, 14-17, 19-22, and 26-28 are obvious under 35 U.S.C. § 103. Accordingly, Appellants respectfully request that the Board find claims 7-9, 14-17, 19-22, and 26-28 patentable over the prior art of record, withdraw all outstanding rejections, and allow claims 7-9, 14-17, 19-22, and 26-28

In accordance with 37 C.F.R. § 1.136, Appellant requests that this and any future reply requiring an extension of time be treated according to the General Authorization For Extensions Of Time previously submitted.

The Commissioner is authorized to charge the requisite fee of $330.00, and any additional fees which may be required, to Account No. 07-0845, Order No. 32-NM-5321/YOD (GEMS:0075).

General Authorization for Extensions of Time

In accordance with 37 C.F.R. § 1.136, Appellants hereby provide a general authorization to treat this and any future reply requiring an extension of time as incorporating a request therefor. Furthermore, Appellants authorize the Commissioner to charge the appropriate fee for any extension of time to Deposit Account No. 07-0845, Order No. 32-NM-5321/YOD (GEMS:0075).

Respectfully submitted,

Date: 1/20/2004

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9. APPENDIX: CLAIMS ON APPEAL

1. (Previously amended) A switching circuit to linearly conduct current between a source and a load, the circuit comprising:

a switching device coupled between the source and the load, the switching device having a conductive state in which a first portion of the current is conducted between the source and the load during a first phase of operation, the first phase of operation dependent on the magnitude of the current applied to the load; and

a current steering circuit coupled between the source and the load and in parallel with the switching device, the current steering circuit having a conductive state in which a second portion of the current is conducted between the source and the load during a second phase of operation in which the magnitude of the current applied to the load is below a non-zero threshold value.

2. (Original) The switching circuit as recited in claim 1, wherein the switching device is in a non-conductive state during the second phase of operation.

3. (Original) The switching circuit as recited in claim 1, wherein the current steering circuit is in a non-conductive state during the first phase of operation.

4. (Previously cancelled).

5. (Original) The switching circuit as recited in claim 1, wherein the second phase of operation occurs when the switching device transitions from the conductive state to a non-conductive state.

6. (Original) The switching circuit as recited in claim1, wherein the switching device transitions from the conductive state to a non-conductive state when the absolute value of the magnitude of the current falls below a non-zero threshold value.

7. (Original) The switching circuit as recited in claim 1, wherein the switching device comprises a silicon controlled rectifier (SCR).

8. (Original) The switching circuit as recited in claim 7, wherein the current steering circuit comprises a transistor to conduct the current during the second phase of operation.

9. (Original) The switching circuit as recited in claim 1, wherein the switching device comprises a pair of anti-parallel silicon controlled rectifiers.

10. (Previously amended) A magnetic resonance imaging (MRI) system to perform an MRI scan in accordance with a pulse sequence, the pulse sequence including at least a first pulse, the system comprising:

a gradient coil assembly to generate a gradient magnetic field during the MRI scan;

an amplifier to drive the gradient coil assembly such that the gradient coil assembly generates the gradient magnetic field in accordance with the pulse sequence; and

a switch assembly to provide a conductive path between the amplifier and the gradient coil assembly, the switch assembly comprising:

a first switching device having a conductive state during a first portion of the first pulse of the pulse sequence, the first portion dependent on the magnitude of a current applied to the gradient coil assembly; and

a second switching device coupled in parallel with the first switching device, the second switching device having a conductive state during a second portion of the first pulse of the pulse sequence during which the~~a~~ current from the amplifier to the gradient coil assembly is below a non-zero threshold value,

wherein the conductive path is provided between the amplifier and the gradient coil assembly during substantially the entire duration of the first pulse.

11. (Original) The system as recited in claim 10, wherein the first portion of the first pulse of the pulse sequence is dependent on the magnitude of current conducted through the first switching device.

12. (Original) The system as recited in claim 11, wherein the second portion of the first pulse occurs when the magnitude of the current conducted through the first switching device reaches a non-zero threshold value.

13. (Original) The system as recited in claim 10, wherein the first switching device and the second switching device are uni-directional current-conducting devices, each of the first and second switching devices conducting current in the same direction between the amplifier and the gradient coil assembly.

14. (Original) The system as recited in claim 10, wherein the first switching device comprises a silicon controlled rectifier.

15. (Original) The system as recited in claim 14, wherein the second switching device comprises a transistor.

16. (Original) The system as recited in claim 10, the switching assembly comprising:

a third switching device coupled in parallel with the first switching device, the third switching device having a conductive state during a first portion of a second pulse of the pulse sequence, the second pulse having a polarity opposite of the first pulse; and

a fourth switching device coupled in parallel with the third switching device, the second switching device having a conductive state during a second portion of the second pulse of the pulse sequence, such that the conductive path is provided between the amplifier and the gradient coil assembly during substantially the entire duration of the second pulse.

17. (Original) The system as recited in claim 10, wherein the gradient coil assembly comprises a first gradient coil set and a second gradient coil set, and the switch assembly selectively couples the amplifier to either the first gradient coil set or the second gradient coil set.

18. (Previously amended) A magnetic resonance imaging (MRI) system for acquiring MRI data, the system comprising:

a processor to control acquisition of the MRI data in accordance with a program stored in

a memory, the program including an imaging protocol having a sequence of gradient pulses and a sequence of detection pulses;

a gradient amplifier to drive the gradient coil assembly in accordance with the sequence of gradient pulses;

an MRI scanner to perform an MRI scan in accordance with the stored imaging protocol, the MRI scanner comprising a magnet, a gradient coil assembly, and an RF coil assembly, the gradient coil assembly generating a gradient magnetic field in accordance with the sequence of pulses;

a switch assembly coupled between the gradient amplifier and the gradient coil assembly to provide a conductive path therebetween, the switch assembly comprising:

a first switching device having a conductive state during a first portion of a first gradient pulse, the first portion dependent on the magnitude of a current applied to the gradient coil assembly; and

a second switching device coupled in parallel with the first switching device, the second switching device having a conductive state during a second portion of the first gradient pulse during which thea current from the amplifier to the gradient coil assembly is below a non-zero threshold value,

wherein the conductive path is provided between the gradient amplifier and the gradient coil assembly during substantially the entire duration of the first pulse; and

an RF detector coupled to the RF coil to detect MRI data resulting from the MRI scan in accordance with the sequence of detection pulses.

19. (Original) The system as recited in claim 18, wherein the first switching device comprises a silicon controlled rectifier.

20. (Original) The system as recited in claim 18, wherein the switch assembly comprises:

a third switching device coupled in anti-parallel with the first switching device, the third switching device having a conductive state during a first portion of a second gradient pulse, the second gradient pulse having a polarity opposite the first gradient pulse; and

a fourth switching device coupled in parallel with the third switching device, the fourth switching device having a conductive state during a second portion of the second gradient pulse, such that the conductive path is provided between the gradient amplifier and the gradient coil assembly during substantially the entire duration of the second pulse.

21. (Original) The system as recited in claim 20, wherein the first switch device and the third switching device each comprises a silicon controlled rectifier.

22. (Original) The system as recited in claim 18, wherein the gradient coil assembly comprises a first gradient coil set and a second gradient coil set, and the switch assembly selectively couples the gradient amplifier to either the first gradient coil set or the second gradient coil set.

23. (Previously amended) A method for performing a magnetic resonance imaging (MRI) scan with an MRI system including a gradient coil assembly, the MRI scan being performed in accordance with a pulse sequence, the method comprising:

receiving a pulse sequence;

generating a current to drive the gradient coil assembly in accordance with the pulse sequence, the current comprising a plurality of current pulses;

conducting the current to the gradient coil assembly through a switch assembly, the switch assembly comprising a first switching device and a second switching device coupled in parallel with the first switching device;

placing the first switching device in a conductive state during a first portion of a first current pulse, the conductive state of the first switching device dependent on the magnitude of the current applied to the load during the first current pulse; and

placing the second switching device in a conductive state during a second portion of the first current pulse, such that the current is conducted to the gradient coil assembly during substantially the entire duration of the first current pulse wherein placing the second switching device in the conductive state occurs when the absolute value of the magnitude of the current applied to the load is below a non-zero threshold value.

24. (Previously cancelled).

25. (Original) The method as recited in claim 23, wherein placing the second switching device in the conductive state occurs when the first switching device transitions to a non-conductive state.

26. (Original) The method as recited in claim 23, wherein the switch assembly comprises a third switching device coupled in anti-parallel with the first switching device, and a fourth switching device coupled in parallel with the third switching device, and the method comprises:

placing the third switching device in a conductive state during a first portion of a second current pulse, the second current pulse having a polarity opposite the first current pulse, the conductive state of the third switching device being dependent on the magnitude of the current during the second current pulse; and

placing the fourth switching device in a conductive state during a second portion of the second current pulse, such that the current is conducted to the gradient coil assembly during substantially the entire duration of the second current pulse.

27. (Original) The method as recited in claim 23, wherein the gradient coil assembly comprises a first set of gradient coils and a second set of gradient coils, and the method comprises:

coupling the switch assembly to the first set of gradient coils;

conducting the current to the first set of gradient coils during the first pulse sequence;

coupling the switch assembly to the second set of gradient coils; and

conducting the current to the second set of gradient coils during a second pulse sequence.

28. (Original) The method as recited in claim 23, comprising:

generating MRI data as a result of the MRI scan; and

detecting the MRI data.

OIPE JC10 JAN 22 2004 PATENT & TRADEMARK OFFICE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Raphael Yair et al.		§ § §	Group Art Unit: 2859
Serial No.:	09/541,354	§ §	Examiner: Fetzner, Tiffany A.
Filed:	March 31, 2000	§ §	
For:	SWITCHING DEVICE TO LINEARLY CONDUCT A CURRENT BETWEEN A SOURCE AND A LOAD	§ § § §	Atty. Docket: GEMS:0075/YOD 32-NM-5321

Mail Stop Appeal Brief-Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

CERTIFICATE OF MAILING
37 C.F.R. 1.8

I hereby certify that this correspondence is being deposited with the U.S. Postal Service with sufficient postage as First Class Mail in an envelope addressed to: Commissioner for Patents, Mail Stop Appeal Brief-Patents, P.O. Box 1450,Alexandria, VA 22313-1450, on the date below:

1/20/04	F. Clay Faries
Date	F. Clay Faries

APPEAL BRIEF PURSUANT TO 37 C.F.R. §§ 1.191 AND 1.192

This Appeal Brief is being filed in triplicate in furtherance to the Notice of Appeal filed on November 17, 2003.

1. REAL PARTY IN INTEREST

The real party in interest is GE Medical Technology Services, Inc., the Assignee of the above-referenced application by virtue of the Assignment recorded at reel 010722, frame 0508, and recorded on March 31, 2000. GE Medical Technology Services, Inc., the Assignee of the above-referenced application, as evidenced by the documents mentioned above, will be directly affected by the Board's decision in the pending appeal.

2. RELATED APPEALS AND INTERFERENCES

Appellants are unaware of any other appeals or interferences related to this Appeal.

3. **STATUS OF CLAIMS**

Claims 1-3, 5-23 and 25-28 are currently pending, and claims 1-3, 5-23 and 25-28 are currently under final rejection and, thus, are the subject of this appeal.

4. **STATUS OF AMENDMENTS**

All proposed amendments have been entered and considered.

5. **SUMMARY OF THE INVENTION AND OF THE DISCLOSED EMBODIMENTS**

In MR imaging systems, failure to maintain uninterrupted linear conduction of current between the gradient amplifier and the gradient coils may compromise the pulse sequence and result in poor imaging performance. Accordingly, the switching assembly that directs the gradient current from the amplifier to the coils should be capable of uninterrupted linear conduction. A problem with conventional systems is that when gradient currents approach zero during normal MRI operation, typical switching devices that direct the gradient current may become non-conductive. In response, the present technique takes into account the magnitude of the current flowing through the gradient coils, and provides for a switching circuit or assembly configured to substantially linearly conduct current between the gradient amplifiers and gradient coils, even if the gradient current approaches zero. Moreover, with phases of operation of the switching device dependent on the magnitude of the current applied to the coils, the switching devices (e.g., steering circuit discussed below) that conduct the gradient current at low levels (e.g., hundreds of milliamperes) may be advantageously sized as smaller components.

As illustrated in Fig. 5 of the application, the present switching assembly 90 includes a switching device 102 and a steering circuit 104 coupled in parallel between the drive 101 (e.g., gradient amplifier) and the load 103 (e.g., gradient coils). The steering circuit 104 is provided to direct the current between the drive 101 and the load 103 in the event that the switching device 102 cannot conduct current in a linear or uninterrupted manner, such as when the magnitude of the current is below a threshold value. For example, as best illustrated in Figs. 8 and 9 of the application, as the magnitude of the current approaches zero, the switching device 102 may fail to conduct current from the drive 101 to the load 103. To ensure uninterrupted linear flow of

current, the steering circuit 104 conducts current at these very low levels (e.g., hundreds of milliamperes) when the switching device 102 is in a non-conducting state. Thus, it is clear that the conductive states of the switching device and steering circuit are *dependent on the magnitude of the current through the gradient coils*. Again, an advantage in basing conductive states within the switching assembly 90 on the magnitude of the current applied to the gradient coils is that the steering circuit 104 will typically conduct only low levels of current. Thus, the steering circuit 104 may comprise smaller non-power components, reducing the size of the steering circuit 104 and improving the packaging of the switching assembly 90.

6. **ISSUES**

Issue No. 1:

Whether claim 1 is unpatentable under 35 U.S.C. § 102 (b) as being anticipated by Macovski et al. (U.S. Pat. No. 5,835,995).

Issue No. 2:

Whether claims 1, 2, 3, 5, 6, 10-13, 18, 23, 25 and 28 are unpatentable under 35 U.S.C. § 102 (e) as being anticipated by Van Groningen (U.S. Pat. No. 6,140,873).

Issue No. 3:

Whether claims 7-9, 14, 15 and 19 are unpatentable under 35 U.S.C. § 103 (a) as being obvious over Van Groningen (U.S. Pat. No. 6,140,873) in view of Mansfield et al. (U.S. Pat. No. 4,820,986) or alternatively Macovski et al. (U.S. Pat. No. 5,835,995).

Issue No. 4:

Whether claims 16, 20, and 26 are unpatentable under 35 U.S.C. § 103 (a) as being obvious over Van Groningen (U.S. Pat. No. 6,140,873) in view of Vavrek et al. (U.S. Pat. No. 5,311,135).

Issue No. 5:

Whether claims 17, 22, and 27 are unpatentable under 35 U.S.C. § 103 (a) as being obvious over Van Groningen (U.S. Pat. No. 6,140,873) in view of Vavrek et al. (U.S. Pat. No. 5,311,135).

Issue No. 6:

Whether claim 21 is unpatentable under 35 U.S.C. § 103 (a) as being obvious over Van Groningen (U.S. Pat. No. 6,140,873) in view of Vavrek et al. (U.S. Pat. No. 5,311,135) and Mansfield et al. (U.S. Pat. No. 4,820,986) or alternatively Vavrek et al. (U.S. Pat. No. 5,311,135) and Macovski et al. (U.S. Pat. No. 5,835,995).

7. **GROUPING OF CLAIMS**

The claims may collectively stand or fall for purposes of this Appeal only.

8. **ARGUMENT**

As discussed in detail below, the Examiner has improperly rejected pending claims 1-3, 5-23 and 25-28. The Examiner has misapplied long-standing and binding legal precedents and principles in rejecting the claims under 35 U.S.C. § 102 and 35 U.S.C. § 103. Appellant believes that this application should have been allowed in view of the Responses to the rejections filed in the present case. Accordingly, Appellant respectfully requests full and favorable consideration by the Board, as Appellant strongly believes that claims 1-3, 5-23 and 25-28 are currently in condition for allowance.

Issue No. 1:

In the most recent Official Action mailed on August 19, 2003, the Examiner rejected claim 1 under 35 U.S.C. §102(b) as being anticipated by Macovski et al. (U.S. Pat. No. 5,835,995). Appellants respectfully traverse this rejection. A *prima facie* case of anticipation under 35 U.S.C. § 102 requires a showing that each limitation of a claim is

found in a single reference, practice or device. *In re Donohue*, 226 U.S.P.Q. 619, 621 (Fed. Cir. 1985).

The Examiner argues incorrectly that Macovski et al. reference discloses a switching device having "a first phase of operation dependent on the magnitude of the current applied to the load," as recited by rejected claim 1. To the contrary, the positions of the switches disclosed in the Macovski et al. reference are selected *by a control input without consideration of the current applied to the load* (coil 11). In fact, timing of the switches depend on factors external to the circuitry, such as the patient's cardiac cycle. As discussed below, the Examiner has failed to show that Macovski et al. reference recites all of the elements of claim 1, and thus has not established a *prima facie* case of anticipation.

The Macovski et al. reference is directed to resolving issues with cardiac imaging timing that are difficult because of cardiac and respiratory motion. Macovski et al., col. 1, lines 29-37. An energy recovery system is used to conserve the energy from the high magnetic fields generated to correct the motion problems. Macovski et al., col. 3, lines 53-67. Various switches and capacitors may be configured in the energy recovery system. Macovski et al., col. 4, lines 1-49. In particular, switches 21, 26, 32, and 34 are opened and closed to control the flow of current and to manage the ramp up and ramp down periods. Macovski et al., col. 4, lines 1-49. Finally, it is clear that the conductive states of the switches are dependent on an external control input and are not determined by the current applied to a load.

In the rejection, the Examiner identifies the discussion of Figs. 3-5 of the Macovski et al. reference to disclose the recited features of independent claim 1. The Examiner cited switches 32 and 34 as correlating to the steering circuit of the recited claims. However, as previously asserted, the Macovski et al. reference fails to disclose a switching device having a "first phase of operation dependent on the magnitude of the current applied to the load," as recited by rejected claim 1. Instead, the Macovski et al. reference discloses that the switch positions are altered when it is desired to charge the coil 11, or to maintain the field, or to ramp down the coil 11. For example, a switch 21 is moved to position 23 to charge the coil 11. Macovski et al., col.

4, lines 1-5. Subsequently, the switch 21 is opened and a switch 26 is closed once a desired field is reached. Macovski et al., col. 4, lines 5-10. Finally, for the downramp 42, the switch 26 is opened and the switch 21 is moved to position 24. Macovski et al., col. 4, lines 10-13. Optional switches 32 and 34 may be used to decrease or increase the downramp or up ramp time for the system. Macovski et al., col. 4, lines 31-49. Clearly, no phase of operation is *dependent* on the *magnitude of the current*, but is controlled by the switches 21, 26, 32, and 34. As such, the Macovski et al. reference fails to disclose a first phase that depends upon the magnitude of the current applied to the load, as claimed.

The Examiner disagreed with Appellants' arguments, asserting:

> Applicant argues [that] the Marcovski et al., reference which controls the flow of current with switches (i.e., this limitation is required by applicant's claim 1, because applicant claims "a switching circuit which linearly conducts current between a source and a load") is directed to a different issue. However, applicant's claim 1 is directed to just a switching circuit to conduct a current. Therefore any circuit which directs current linearly between a source and a load meets applicant's claim 1. The fact that the Marcovski et al., reference uses the Marcovski et al., switching circuit in MR cardiac imaging, fails to eliminate the Marcovski et al. reference as prior art, because the limitations claimed by the applicant are still met by the reference. Applicant's argument is not persuasive.

Paper No. 10, page 2, paragraph 4A.

Appellants respectfully disagree with the Examiner's assertion that any circuit which directs current linearly between a source and a load anticipates claim 1. To the contrary, anticipation under 35 U.S.C. § 102 can be found only if a single reference shows exactly what is claimed. *Titanium Metals Corp. v. Banner*, 778 F.2d 775, 227 U.S.P.Q. 773 (Fed. Cir. 1985). The cited reference fails this standard with respect to claim 1 for at least the reason that the reference does not disclose a phase of operation "dependent on the magnitude of the current applied to the load." In short, the Macovski et al. et al. reference does not disclose all of the limitations of claim 1.

Appellants agree with the Examiner that the primary use of the Macovski et al. switching circuit in cardiac imaging does not necessarily eliminate the reference as prior art. However, recognition of this focus of the reference is useful in understanding the deficiencies of the reference. For example, as discussed below, the reference discloses a preference for timing the operation of the switches to the patient's cardiac cycle, a factor clearly external to the circuitry and not "dependent on the magnitude of the current applied to the load," as recited by claim 1. *See* Makovski et al., col. 4, lines 55-61.

The Examiner further stated:

> Applicant argues [that] the Marcovski et al. reference fails to disclose a switching device having a "first phase of operation dependent on the magnitude of the current applied to the load." However, Marcovski et al., shows and teaches a switching device with a first phase (i.e., at least one switch in a first position until a specified set of conditions are met) and a second phase (i.e., at least one switch in a second position when a second set of conditions are met) that affects the inductive load component 11.

Paper No. 10, pages 2-3, paragraph 4B.

The Examiner asserts that Marcovski et al. discloses first and second phases of operation of at least one switch dependent on a "specified set of conditions." Operation of the Marcovski et al. switches, however, are not dependent on magnet current, but instead is controlled by a computer program to give the desired ramp slopes and times. In particular, the switching devices that conduct current to the load (coils) in the Macovski et al. device are "actuated by a pre-set computer program." Such actuation is dependent on desired ramp up and ramp down intervals. Macovski et al., col. 4, lines 1-46, 53-54. Thus, again, the positions of the switches are manipulated by an external control input. The reference does not disclose a switching device having a conductive state dependent on the magnitude of a current.

Conversely, in the present application, as illustrated in Figs. 4-6, after exemplary switching assemblies 90 are enabled by a control circuit (i.e., 40 or 105), the *conductive states of*

switching devices (i.e., 102, 104, 114, 116, 106, 108) within the assemblies 90 *are clearly decided by the magnitude of the current applied to the load* (i.e., 26, 41-45, 103). Again, this is in sharp contrast to the cited reference, in which the conductive states of the switches are independent of the current applied to the load. For example, in the Macovski et al. reference, the conductive states of switches 21 and 26 are adjusted to initiate a downramp 42, with no consideration of the magnitude of the current applied to the load. Indeed, prior to the downramp 42, the magnitude of the current is at a constant peak value, hardly a changing variable that might initiate a change in the conductive state of a switch. *See* Macovski et al., col. 5-13. And just as striking, the cited reference suggests that the timing of the switches will preferentially depend completely on factors external to the disclosed circuitry (and not to the magnitude of the current through the coils):

> With cardiac studies, which is one of the primary uses of this invention, the switches would be timed to the cardiac cycle using a signal derived from the beating heart such as the electrocardiogram. When making a static image of the heart, as with a coronary angiogram, the system is timed to an appropriate part of the heart cycle . . . .

Macovski et al., col. 4, lines 55-61.

The Examiner's confusion is highlighted by the Examiner's incorrect characterization of the operation of the capacitor 25 in the Macovski et al. reference:

> Marcovski et al., teaches that the switches are activated or deactivated dependent upon the rate of change of current (i.e. di/dt) charging/discharging a capacitor, [See col. 4 line 1 through col. 6 line 11] and because the rate of change of current (i.e. di/dt) charging/discharging a capacitor is related to the current magnitude in the circuit containing the capacitor, depending on the situational position of the switches of Figure 4, and different for a second position of the switches of Figure 4, thus applicant's argument is not persuasive.

Paper No. 10, page 3, paragraph 4B.

Appellants respectfully disagree. Even if the current ramp di/dt, which is a function of voltage 22 (E) and inductance of the coils 11 (L), is related to the current charging/discharging

the capacitor 25 or to the magnitude of the current in the coils 11, none of these variables affect operation of the Makovski et al. switches. *See* Macovski et al., col. 4, lines 6-7. It is clear that the current ramp di/dt (or any other current variables) does not decide the position or conductive states of switching devices in the disclosed circuitry. Instead, the positions of the switches are determined by external factors, such as initially, when the user (or pre-set computer program) decides to *manipulate* the switches to charge the capacitor 25 and to initiate the cardiac imaging sequence. The capacitor is initially charged through diode 26, and then discharged to the coils for a di/dt ramp up. Macovski et al., col. 4, lines 1-6 (noting that after the capacitor is charged, "the pulse is initiated by *turning* switch 21," and after achieving the desired magnetic field, the "switch 21 is *put* in a [different] position and switch 26 is *turned on*") (emphases added). To complete the energy recovery cycle, a reverse voltage is applied for the downramp, the capacitor 25 receiving a return charge from the coils 11. Macovski et al., col. 4, lines 10-15 (explaining that to discharge the coils 11, the "switch 26 is *opened* and switch 21 is *moved*") (emphases added).

It should be apparent that the Examiner's focus on the capacitor 25 in rejecting the present claims is misplaced. The capacitor 25 is provided for energy recovery and has nothing to do with deciding the position of the switches. Quite the opposite, the operation of the capacitor is instead dependent on the position of the switches, and not vice versa.

In summary, the Makovski et al. reference does not disclose a switching device having phases of operation "dependent on the magnitude of the current applied to the load," as recited by rejected claim 1. Because the Examiner has failed to show that the prior art recites each element of the claimed invention, the Makovski et al. reference can not anticipate the present claims. Consequently, independent claim 1 and its respective dependent claims 2-3 and 5-9 are believed to be patentable over the Makovski et al. reference. Accordingly, Appellant believes claims 1-3 and 5-9 are currently in condition for allowance, and respectfully requests favorable consideration by the Board.

Issue No. 2:

The Examiner rejected claims 1, 2, 3, 5, 6, 10-13, 18, 23, 25 and 28 under 35 U.S.C. §102 (e) as being anticipated by Van Groningen (U.S. Pat. No. 6,140,873). Appellants respectfully traverse this rejection. To maintain a proper rejection under 35 U.S.C. § 102, a single reference must teach each and every element or step of the rejected claim. *Atlas Powder v. E.I. du Pont*, 750 F.2d 1569 (Fed. Cir. 1984). The Examiner rejected each of independent claims 1, 10, 18 and 23, which recite similar subject matter and were rejected based on the same elements of the Van Groningen reference. Therefore, the independent claims 1, 10, 18 and 23 are discussed together.

Initially, Appellants note that because the magnitude of the current through the load 70 in the Van Groningen reference is assumed constant, the Examiner relied on an amplifier component having variable current flow in an effort to anticipate the claims. In particular, the Examiner equated, incorrectly, the self-inductor 58 (having a "boost" current) of the Van Groningen reference with the "load" and "gradient coils assembly" of the present application. It is clear, however, that the "load" of the present application is separate from the switching device, steering circuit, and overall switching assembly. In contrast, the self-inductor 58 of the Van Groningen reference is a component within the amplifier/switching circuitry and therefore cannot be equated with the "load" or "gradient coils" of the present claims.

In the present application, the switching assembly is disposed *between* the source and the load (or between the amplifier and gradient coil assembly). For example, claim 1 recites, "a switching device coupled *between* the source and the load." Thus, it is not possible for the load to be a part of the switching device or assembly. The load receives (or returns) current from the switching assembly, and is separate from the switching circuitry. After all, a purpose of the switching assembly is to conduct current *to the load.* Dissimilarly, the self-inductor 58 of the cited reference is part of the switching circuitry and clearly cannot conduct current to itself. Indeed, the self-inductor 58 is a component utilized in the conduction of current *to the load 70.*

In sum, the Examiner's labeling of the self-inductor 58 of the cited reference as the load or gradient coil assembly of the present application is plainly misplaced. The Examiner has not

challenged that the current in load 70 or through the gradient coils 3 is constant, but instead has interpreted erroneously the self-inductor 58 within the Van Groningen switching circuitry as the load or gradient coils of the present application. Accordingly, because operation of the switches in the Van Groningen reference does not *depend* on the *magnitude of the current applied to the load or gradient coil assembly*, as recited in the claims, the Van Groningen switches fail to anticipate the recited feature.

In general, as recited in the pending claims and as particularly described in the specification of the instant application, the switching device and the steering circuit are different, independent circuits that are connected in parallel to permit current to be supplied to a gradient coil assembly even when the switching device ceases to conduct current. It is clear that the steering circuit and the switching device are configured to alternately conduct current depending on the current level. As discussed above, the current steering circuit 104 is coupled in parallel with the switching device 102 to provide an alternate path between the drive 101 (e.g., amplifier 96) and the load 103 (e.g., gradient coil 42), which depends on the magnitude of the current. As shown in the waveforms 152 and 160, the steering circuit and the switching device operate to ensure that current is conducted to the gradient coil assembly during substantially the entire duration of the first current pulse.

Conversely, the Van Groningen reference is directed to resolving switching losses in amplifiers because of the switching over from one state to another. Van Groningen, col. 2, lines 30-43. To resolve this problem, the Van Groningen reference utilizes "soft switching," which is intended to minimize the current loss through the switches. Van Groningen, col. 2, lines 44-53. The reference teaches using a capacitor in parallel with a controllable switch to ensure that the voltage across the switches is nearly zero. Van Groningen, col. 3, line 61 to col. 4, line 21. The transistors 36 and 38 are *controllable* switches that are activated and deactivated by a control input. Van Groningen, col. 3, lines 30-42; col. 8 lines 7-26. The Van Groningen reference discloses three situations to illustrate the "soft switching" in the circuit, which involve switching over between a diode 42 and a transistor 36. Van Groningen, col. 7, line 46 to col. 9, line 33. In each of the situations, the voltage level at the switch is adjusted before being activated or

deactivated. Van Groningen, col. 7, line 46 to col. 9, line 33. During the situations, a boost current and a clamping phase may be used, while *the current through the load 70 is assumed to be constant.* Van Groningen, col. 7, line 46 to col. 8, line 36.

In the rejection, the Examiner asserted that the Van Groningen reference discloses all of the recited features. Further, the Examiner asserted that the transistors 36 and 38 are equivalent to the switching device and the components 60-1, 60-2, 60-3, 64-1, 64-2, and 64-3 are equivalent to the current steering circuit. However, the Van Groningen reference does not disclose or suggest all of the recited features of the claims. For example, the Van Groningen reference does not provide *a first phase of operation* or *a first portion* that is *dependent* on the *magnitude of the current applied to the load or gradient coil assembly.*

In the rejection, the Examiner asserted that the transistors 36 and 38 are equivalent to the switching device recited in the claims. In the Van Groningen reference, the only description of the current through the load 70 indicates that the load current is assumed to be constant. Van Groningen, col. 7, lines 57-59; col. 9, lines 66-67. The magnitude of the current is not even a factor for the operation of the switches 36 and 38. This is because the *controllable* switches 36 and 38 operate from a control input, not the magnitude of the current applied to the load. Van Groningen, col. 3, lines 30-42. Specifically, to comply with the soft switching, as taught by the reference, the *boost current*, and not the load current, is utilized to adjust the voltage differential across the switch 36 or 38 to nearly zero to allow the switch to switch over in a lossless manner Van Groningen, col. 2, lines 44-51; col. 8, lines 7-23. Because operation of the switches 36 and 38 do not *depend* on the *magnitude of the current applied to the load or gradient coil assembly*, as recited in the claims, the switches 36 and 38 fail to anticipate the recited feature.

The Examiner disagreed, stating:

> Applicant argues [that] the Van Groningen reference which minimizes current loss through switches is directed to a different issue than applicant's invention. However, applicant's claim 1 is directed to just a switching circuit to conduct a current. Therefore the fact that the Van Groningen reference uses the Van Groningen switching circuit to resolve switching losses in MR amplifiers,

> fails to eliminate the Van Groningen referenced as prior art, because the limitations claimed by applicant are still met by the reference.

Paper No. 10, page 3, paragraph 4C.

Appellants clarify that claim 1 is directed to "a switching circuit to linearly conduct current between a source and a load," as recited in the preamble. Furthermore, Appellants agree with the Examiner that the fact that the Van Groningen reference is directed to minimizing switching losses in MR amplifiers does not necessarily eliminate the Van Groningen reference as prior art. It is useful, however, to recognize this very different focus of the cited reference in understanding the deficiencies of the reference. For example, because the purpose of Van Groningen is to minimize losses in the switching between a diode 42 and a transistor 36 *within the amplifier*, the reference only minimally addresses the current through load 70 or gradient coils 3. The reference discusses the magnitude of the current through the amplifier components, such as the current through the self-inductor 58, but does not directly address the magnitude of the current through the load (except for indicating that the current through the load is constant). Thus, the Examiner has erroneously disregarded the teaching of Van Groningen regarding the current through the load 70 or gradient coil 3, but instead relies on the disclosed changing current through amplifier components in an effort to anticipate the claims. For example, as discussed above, the Examiner treats an amplifier component, the self-inductor 58, as a "load." A problem with this approach, however, (as clearly established by the subject matter of the present claims) is that the "load" of the present claims is not part of the "source" or "amplifier" or "switching assembly," and thus the self-inductor 58 (which is part of the amplifier/switching circuitry) of the cited reference is not equivalent to the "load" of the present application.

And just as striking, while the focus of Van Groningen is minimizing switching losses with assumed satisfactory delivery of current to the load 70, the current flowing through the amplifier components, such as through the self-inductor 58, is not necessarily uninterrupted or linear. For example, unlike the current flowing through the "load" of the claims, it is not important for the current through the self-inductor 58 to be linear. In fact, at the time of switching disclosed in the Van Groningen reference (i.e., during the resonant switching phase),

the current through the self-inductor is not linear but sinusoidal in form. Van Groningen, col. 8, lines 6-8, 14-16, 65-67.

In the most recent Office Action, the Examiner argued that the position of the Van Groningen switches in Figures 2, 3, and 4 are situational, with the magnitude of the current applied to inductor 58 of Figure 2 changing for each situation. The Examiner cited col. 5 line 66 through col.11 line 11 of the reference and again reasoned incorrectly that the inductive component 58 is also effectively a load within Van Groningen's circuitry (through which current passes), and interpreted that each of the positional switch situations is "a first phase of operation or a first portion" (i.e. a first set of switch positions) that is "dependent on the magnitude of the current applied to the load" (or "gradient coil assembly"), with the "load" being the inductive component 58 of Figure 2. The Examiner continues to equate, incorrectly, the self-inductor 58 (which is not the load 70 but is a component of the switching circuitry) of the cited reference with the "load" or "gradient coil assembly" recited in the present claims. Appellants have carefully reviewed the portions of the reference cited by the Examiner and respectfully disagree that the inductive component 58 is equivalent to the load of the present application.

What is more, the Van Groningen reference also fails to disclose a *second switching device* or *current steering circuit* having a *second portion* of *current to the load or gradient coils* being "below a non-zero threshold value." In the rejection, the Examiner asserted that components 60-1, 60-2, 60-3, 64-1, 64-2, and 64-3 of Van Groningen are equivalent to the current steering circuit. However, as discussed previously, the only disclosure in the Van Groningen reference related to the current through the load 70 is that it is assumed to be constant. Van Groningen, col. 7, lines 57-59; col. 9, lines 66-67. In fact, the reference is devoid of any disclosure that the current through the load falls "below a non-zero threshold value" or that any action is taken based upon such events. Accordingly, the reference cannot disclose or anticipate a *second portion of current* to the *load* or *gradient coil assembly* that is "below a non-zero threshold value."

The Examiner responded, erroneously, that the Van Groningen reference teaches a *second switching device* or *steering circuit* (citing the components of Figure 2) having a *second portion of current to the load* (i.e., a second configuration of switch positions) resulting in an alteration of current through the inductive load component 58. Furthermore, the Examiner misinterpreted the "half-period" disclosed in the reference as the "non-zero-threshold value" recited in the claims. Finally, the Examiner concluded that "because the reference teaches the switching which occurs in each type of situation depends upon the amount of current through the switch components, the applicant's argument [stating] that the Van Groningen reference is devoid of action which occurs when current through the load (i.e. interpreted by the examiner as inductive component 58) falls below 'a non-zero threshold value' is not persuasive." Paper No. 10, pages 3-4, paragraph 4D.

Again, Appellants note that the self-inductor 58 obviously not a gradient coil assembly, and is not a "load" described by the claims for at least the reason of the different location of the self-inductor 58 compared to the location of the load (and gradient coils) of the present application. Even the Examiner has acknowledged that the self-inductor 58 is disposed within the switching circuitry, and thus the Examiner's configuration of the self-inductor 58 as a "load" is inconsistent with the present claims. *See* Paper No. 10, page 4, paragraph 4D (noting that self-inductor 58 is also effectively a load within Van Groningen's circuitry and that the switching depends upon the amount of current through the self-inductor 58, a switching component). The "load" in the present claims is not part of the amplifier or switching assembly but receives current from the amplifier and switching assembly. Moreover, as previously indicated, the self-inductor 58 is used to minimize switching losses within the amplifier and does not require linear uninterrupted flow of current, whereas the gradient coils of the present application are used to generate gradient magnetic fields and require linear uninterrupted flow of current. Furthermore, the "half-period" discussed in the Van Groningen reference is not equivalent to the "non-zero threshold value," as recited in the claims. Appellants repeat that the only disclosure in the Van Groningen reference related to the current through the load 70 is that it is assumed to be constant. Van Groningen, col. 7, lines 57-59; col. 9, lines 66-67. Appellants also repeat that the reference is devoid of any disclosure that the current through the load falls "below a non-zero threshold

value" or that any action is taken based upon such events. Accordingly, the reference cannot disclose or anticipate a *second portion of current* to the *load* or *gradient coil assembly* that is "below a non-zero threshold value."

In view of the remarks set forth above, Appellants respectfully submit that the subject matter of independent claims 1, 10, 18 and 23, as well as the claims dependent thereon, is not anticipated by Van Groningen reference. Accordingly, Appellants believe claims 1-3, 5, 6, 10-13, 18, 23, 25 and 28 are currently in condition for allowance, and respectfully requests favorable consideration by the Board.

<u>Issue No. 3</u>:

Claims 7-9, 14, 15 and 19 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Van Groningen (U.S. Pat. No. 6,140,873) in view of Mansfield et al. (U.S. Pat. No. 4,820,986) or alternatively Macovski et al. (U.S. Pat. No. 5,835,995). As discussed above, all of the independent claims are believed to be allowable over the Van Groningen reference. The Examiner relied upon the Mansfield et al. reference or the Macovski et al. reference to disclose or teach a "switching device comprises a silicon controlled rectifier (SCR)." However, the Mansfield et al. reference and the Macovski et al. reference do nothing to obviate the deficiencies of the Van Groningen reference discussed above. Moreover, the Examiner has yet to provide a convincing line of reasoning for the proposed combination. Appellants believe that the teachings are not in fact amenable to a workable combination. Therefore, all of the cited dependent claims are believed to be patentable for the subject matter they separately recite as well as by virtue of their dependency on their respective allowable base claims 1, 10, and 18. Accordingly, Appellants believe claims 7-9, 14, 15 and 19 are currently in condition for allowance, and respectfully requests favorable consideration by the Board.

<u>Issue No. 4</u>:

The Examiner rejected claims 16, 20, and 26 under 35 U.S.C. 103(a) as being unpatentable over Van Groningen (U.S. Pat. No. 6,140,873) in view of Vavrek et al. (U.S. Pat. No. 5,311,135). As discussed above, all of the independent claims are believed to be allowable

over the Van Groningen reference. In the rejection, the Examiner appears to rely on Vavrek et al. to the disclose or teach the "gradient coil assembly." However, the Vavrek et al. reference does nothing to obviate the deficiencies of the Van Groningen reference with regard to the deficiencies discussed above. Moreover, the Examiner has yet to provide a convincing line of reasoning for the proposed combination. Appellants believe that the teachings are not in fact amenable to a workable combination. Accordingly, all of the cited dependent claims are believed to be patentable for the subject matter they separately recite as well as by virtue of their dependency on an allowable base claim. Therefore, Appellants believe claims 16, 20, and 26 are currently in condition for allowance, and respectfully requests favorable consideration by the Board.

Issue No. 5:

The Examiner rejected claims 17, 22, and 27 under 35 U.S.C. 103(a) as being unpatentable over Van Groningen (U.S. Pat. No. 6,140,873) in view of Vavrek et al. (U.S. Pat. No. 5,311,135). As discussed above, all of the independent claims are believed to be allowable over the Van Groningen reference. In the rejection, the Examiner relied on Vavrek et al. to the disclose or teach the "a first gradient coil set and a second gradient coil set" and "the switch assembly selectively couples the amplifier to either the first gradient coil set or the second gradient coil set." However, the Vavrek et al. reference does nothing to obviate the deficiencies of the Van Groningen reference with regard to the deficiencies discussed above. Moreover, the Examiner has yet to provide a convincing line of reasoning for the proposed combination. Appellants believe that the teachings are not in fact amenable to a workable combination. Accordingly, all of the cited dependent claims are believed to be patentable for the subject matter they separately recite as well as by virtue of their dependency on an allowable base claim. Therefore, Appellants believe claims 17, 22, and 27 are currently in condition for allowance, and respectfully requests favorable consideration by the Board.

Issue No. 6:

Claim 21 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Van Groningen (U.S. Pat. No. 6,140,873) in view of Vavrek et al. (U.S. Pat. No. 5,311,135) and

Mansfield et al. (U.S. Pat. No. 4,820,986) or alternatively Vavrek et al. (U.S. Pat. No. 5,311,135) and Macovski et al. (U.S. Pat. No. 5,835,995). As discussed above, the independent claim 18 is believed to be allowable over the Van Groningen reference, and dependent claim 20 is believed to be allowable over Van Groningen in view of Vavrek et al. The Examiner relied upon the Mansfield et al. or Macovski et al. reference to disclose or teach "the first switch device and the third switching device each comprises a silicon controlled rectifier." However, the Mansfield et al. reference and Macovski et al. reference do nothing to obviate the deficiencies of the Van Groningen and Vavrek et al. references discussed above. Moreover, the Examiner has yet to provide a convincing line of reasoning for the proposed combination. Appellants believe that the teachings are not in fact amenable to a workable combination. Accordingly, dependent claim 21 is believed to be patentable for the subject matter it recites as well as by virtue of its dependency on allowable base claim 18. Accordingly, Appellants believe claim 21 is currently in condition for allowance, and respectfully requests favorable consideration by the Board..

CONCLUSION

In view of the above remarks, Appellants respectfully submit that the Examiner has provided no supportable position or evidence that claims 1, 2, 3, 5, 6, 10-13, 18, 23, 25 and 28 are anticipated under 35 U.S.C. § 102. Accordingly, Appellants respectfully request that the Board find claims 1, 2, 3, 5, 6, 10-13, 18, 23, 25 and 28 patentable over the prior art of record, withdraw all outstanding rejections, and allow claims 1, 2, 3, 5, 6, 10-13, 18, 23, 25 and 28.

Furthermore, in view of the above remarks, Appellants respectfully submit that the Examiner has provided no supportable position or evidence that remaining pending claims 7-9, 14-17, 19-22, and 26-28 are obvious under 35 U.S.C. § 103. Accordingly, Appellants respectfully request that the Board find claims 7-9, 14-17, 19-22, and 26-28 patentable over the prior art of record, withdraw all outstanding rejections, and allow claims 7-9, 14-17, 19-22, and 26-28

In accordance with 37 C.F.R. § 1.136, Appellant requests that this and any future reply requiring an extension of time be treated according to the General Authorization For Extensions Of Time previously submitted.

The Commissioner is authorized to charge the requisite fee of $330.00, and any additional fees which may be required, to Account No. 07-0845, Order No. 32-NM-5321/YOD (GEMS:0075).

General Authorization for Extensions of Time

In accordance with 37 C.F.R. § 1.136, Appellants hereby provide a general authorization to treat this and any future reply requiring an extension of time as incorporating a request therefor. Furthermore, Appellants authorize the Commissioner to charge the appropriate fee for any extension of time to Deposit Account No. 07-0845, Order No. 32-NM-5321/YOD (GEMS:0075).

Respectfully submitted,

Date: 1/20/2004

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9. APPENDIX: CLAIMS ON APPEAL

1. (Previously amended) A switching circuit to linearly conduct current between a source and a load, the circuit comprising:

a switching device coupled between the source and the load, the switching device having a conductive state in which a first portion of the current is conducted between the source and the load during a first phase of operation, the first phase of operation dependent on the magnitude of the current applied to the load; and

a current steering circuit coupled between the source and the load and in parallel with the switching device, the current steering circuit having a conductive state in which a second portion of the current is conducted between the source and the load during a second phase of operation in which the magnitude of the current applied to the load is below a non-zero threshold value.

2. (Original) The switching circuit as recited in claim 1, wherein the switching device is in a non-conductive state during the second phase of operation.

3. (Original) The switching circuit as recited in claim 1, wherein the current steering circuit is in a non-conductive state during the first phase of operation.

4. (Previously cancelled).

5. (Original) The switching circuit as recited in claim 1, wherein the second phase of operation occurs when the switching device transitions from the conductive state to a non-conductive state.

6. (Original) The switching circuit as recited in claim1, wherein the switching device transitions from the conductive state to a non-conductive state when the absolute value of the magnitude of the current falls below a non-zero threshold value.

7. (Original) The switching circuit as recited in claim 1, wherein the switching device comprises a silicon controlled rectifier (SCR).

8. (Original) The switching circuit as recited in claim 7, wherein the current steering circuit comprises a transistor to conduct the current during the second phase of operation.

9. (Original) The switching circuit as recited in claim 1, wherein the switching device comprises a pair of anti-parallel silicon controlled rectifiers.

10. (Previously amended) A magnetic resonance imaging (MRI) system to perform an MRI scan in accordance with a pulse sequence, the pulse sequence including at least a first pulse, the system comprising:

a gradient coil assembly to generate a gradient magnetic field during the MRI scan;

an amplifier to drive the gradient coil assembly such that the gradient coil assembly generates the gradient magnetic field in accordance with the pulse sequence; and

a switch assembly to provide a conductive path between the amplifier and the gradient coil assembly, the switch assembly comprising:

a first switching device having a conductive state during a first portion of the first pulse of the pulse sequence, the first portion dependent on the magnitude of a current applied to the gradient coil assembly; and

a second switching device coupled in parallel with the first switching device, the second switching device having a conductive state during a second portion of the first pulse of the pulse sequence during which thea current from the amplifier to the gradient coil assembly is below a non-zero threshold value,

wherein the conductive path is provided between the amplifier and the gradient coil assembly during substantially the entire duration of the first pulse.

11. (Original) The system as recited in claim 10, wherein the first portion of the first pulse of the pulse sequence is dependent on the magnitude of current conducted through the first switching device.

12. (Original) The system as recited in claim 11, wherein the second portion of the first pulse occurs when the magnitude of the current conducted through the first switching device reaches a non-zero threshold value.

13. (Original) The system as recited in claim 10, wherein the first switching device and the second switching device are uni-directional current-conducting devices, each of the first and second switching devices conducting current in the same direction between the amplifier and the gradient coil assembly.

14. (Original) The system as recited in claim 10, wherein the first switching device comprises a silicon controlled rectifier.

15. (Original) The system as recited in claim 14, wherein the second switching device comprises a transistor.

16. (Original) The system as recited in claim 10, the switching assembly comprising:

a third switching device coupled in parallel with the first switching device, the third switching device having a conductive state during a first portion of a second pulse of the pulse sequence, the second pulse having a polarity opposite of the first pulse; and

a fourth switching device coupled in parallel with the third switching device, the second switching device having a conductive state during a second portion of the second pulse of the pulse sequence, such that the conductive path is provided between the amplifier and the gradient coil assembly during substantially the entire duration of the second pulse.

17. (Original) The system as recited in claim 10, wherein the gradient coil assembly comprises a first gradient coil set and a second gradient coil set, and the switch assembly selectively couples the amplifier to either the first gradient coil set or the second gradient coil set.

18. (Previously amended) A magnetic resonance imaging (MRI) system for acquiring MRI data, the system comprising:

a processor to control acquisition of the MRI data in accordance with a program stored in

a memory, the program including an imaging protocol having a sequence of gradient pulses and a sequence of detection pulses;

a gradient amplifier to drive the gradient coil assembly in accordance with the sequence of gradient pulses;

an MRI scanner to perform an MRI scan in accordance with the stored imaging protocol, the MRI scanner comprising a magnet, a gradient coil assembly, and an RF coil assembly, the gradient coil assembly generating a gradient magnetic field in accordance with the sequence of pulses;

a switch assembly coupled between the gradient amplifier and the gradient coil assembly to provide a conductive path therebetween, the switch assembly comprising:

a first switching device having a conductive state during a first portion of a first gradient pulse, the first portion dependent on the magnitude of a current applied to the gradient coil assembly; and

a second switching device coupled in parallel with the first switching device, the second switching device having a conductive state during a second portion of the first gradient pulse during which thea current from the amplifier to the gradient coil assembly is below a non-zero threshold value,

wherein the conductive path is provided between the gradient amplifier and the gradient coil assembly during substantially the entire duration of the first pulse; and

an RF detector coupled to the RF coil to detect MRI data resulting from the MRI scan in accordance with the sequence of detection pulses.

19. (Original) The system as recited in claim 18, wherein the first switching device comprises a silicon controlled rectifier.

20. (Original) The system as recited in claim 18, wherein the switch assembly comprises:

a third switching device coupled in anti-parallel with the first switching device, the third switching device having a conductive state during a first portion of a second gradient pulse, the second gradient pulse having a polarity opposite the first gradient pulse; and

a fourth switching device coupled in parallel with the third switching device, the fourth switching device having a conductive state during a second portion of the second gradient pulse, such that the conductive path is provided between the gradient amplifier and the gradient coil assembly during substantially the entire duration of the second pulse.

21. (Original) The system as recited in claim 20, wherein the first switch device and the third switching device each comprises a silicon controlled rectifier.

22. (Original) The system as recited in claim 18, wherein the gradient coil assembly comprises a first gradient coil set and a second gradient coil set, and the switch assembly selectively couples the gradient amplifier to either the first gradient coil set or the second gradient coil set.

23. (Previously amended) A method for performing a magnetic resonance imaging (MRI) scan with an MRI system including a gradient coil assembly, the MRI scan being performed in accordance with a pulse sequence, the method comprising:

receiving a pulse sequence;

generating a current to drive the gradient coil assembly in accordance with the pulse sequence, the current comprising a plurality of current pulses;

conducting the current to the gradient coil assembly through a switch assembly, the switch assembly comprising a first switching device and a second switching device coupled in parallel with the first switching device;

placing the first switching device in a conductive state during a first portion of a first current pulse, the conductive state of the first switching device dependent on the magnitude of the current applied to the load during the first current pulse; and

placing the second switching device in a conductive state during a second portion of the first current pulse, such that the current is conducted to the gradient coil assembly during substantially the entire duration of the first current pulse wherein placing the second switching device in the conductive state occurs when the absolute value of the magnitude of the current applied to the load is below a non-zero threshold value.

24. (Previously cancelled).

25. (Original) The method as recited in claim 23, wherein placing the second switching device in the conductive state occurs when the first switching device transitions to a non-conductive state.

26. (Original) The method as recited in claim 23, wherein the switch assembly comprises a third switching device coupled in anti-parallel with the first switching device, and a fourth switching device coupled in parallel with the third switching device, and the method comprises:

placing the third switching device in a conductive state during a first portion of a second current pulse, the second current pulse having a polarity opposite the first current pulse, the conductive state of the third switching device being dependent on the magnitude of the current during the second current pulse; and

placing the fourth switching device in a conductive state during a second portion of the second current pulse, such that the current is conducted to the gradient coil assembly during substantially the entire duration of the second current pulse.

27. (Original) The method as recited in claim 23, wherein the gradient coil assembly comprises a first set of gradient coils and a second set of gradient coils, and the method comprises:

coupling the switch assembly to the first set of gradient coils;

conducting the current to the first set of gradient coils during the first pulse sequence;

coupling the switch assembly to the second set of gradient coils; and

conducting the current to the second set of gradient coils during a second pulse sequence.

28. (Original) The method as recited in claim 23, comprising:

generating MRI data as a result of the MRI scan; and

detecting the MRI data.